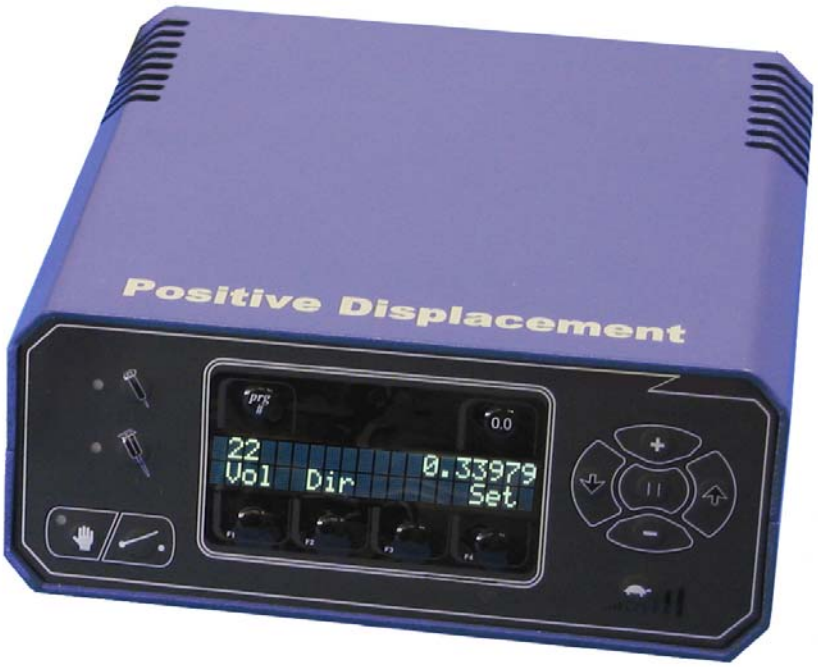
Zaxis Valveless Metering Pump User Manual

Precision fluid metering with ultra-fine electronic adjustment…



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1. Introduction

The Vmp system combines a user-friendly electronically programmable controller and a superior metering head. A linear stepper actuator makes ultra-fine adjustments to the angle of the pump, thereby changing the quantity of metered liquid. This technology employs diamond honing and internal modifications to provide enhanced fluidic movement of solutions varying in viscosity and surface tension. This type of pump is valveless and has only one moving part, the piston. This translates into millions of maintenance cycles (84,000,000). When you do have to conduct maintenance, it is a simple task to disassemble and reassemble, minimizing down time. Combined with the Vmp electronic controller, this system can achieve a high degree of accuracy when metering fluids.

Controlling the synchronized rotating and reciprocating movement allows the Vmp controller to accurately maintain the displacement of the piston. Since the piston is manufactured from ceramic, the pump assembly can be manufactured to extremely tight tolerances, insuring accuracy and repeatability. This pump design eliminates the need for external supply and discharge valves, one port of the pump is open while the other is closed and visa-versa, never allowing both ports to interconnect. The Vmp will change the way industry meters fluids.

1.1. Safety Instructions (*please read before operating controller and pump*)

SAFETY INSTRUCTIONS

Caution: Before using any equipment read the following safety instructions as well as specific product specifications and operating instructions.

Warning! Fire, Electrical shock or explosion may occur if used near combustibles explosive Atmosphere, corrosive air, wet environment or submerged in fluid.

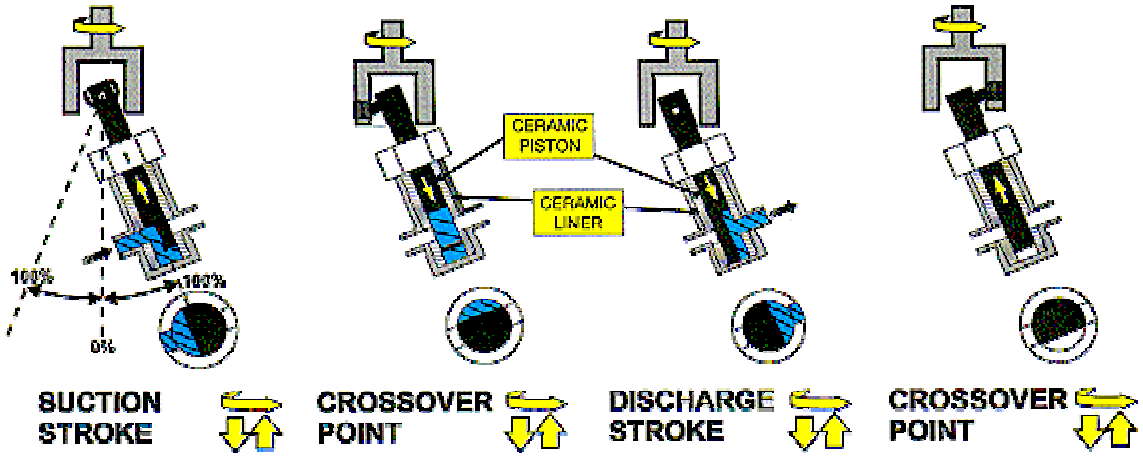
- Turn off electrical power before checking pump for any problems.
- Connect motor, controller or any other electrical devices based on VmP specifications. Any unauthorized work performed on the product by the purchaser or by third parties can impair product functionality and thereby relieves VmP of all warranty claims or liability for any misuse that will cause damage to product and/or injury to the individual.
- Power cables and leads should not be bent, pulled or inserted by excessive force. Otherwise there is a threat of electrical shock of fire.
- Replace any inline fuses only with fuse rating as specified by VmP
- When pump/drive is under operation, never point discharge tubing into face or touch any rotating components of pump. In a power down thermal overload cut-in condition, unplug or turn off power to pump. Always allow a cool down period before restarting: otherwise, injury or damage may occur.
- For 30 seconds after power is removed from pump/drive: do not touch any output terminals. Electrical shock may occur because of residual voltage.
- Do not operate with wet hands.

Caution! Fire, electrical shock, injury and damage may occur f not used in accordance with VmP specifications and operation instructions.

- Do not operate drive assemblies that require a hard mount (to be bolted down) unless they are mounted per VmP specifications, if not, injury may occur and/or damage to unit.
- Do not touch any rotating pump or motor components: injury may occur.
- Do not run pump dry, unless designed for that service. Running dry is harmful to the pump, and will cause excessive heating due to internal friction.
- Fittings screwed too tightly into stainless steel pump heads will contact port seals and may cause piston/cylinder damage. Use extra layers of Teflon tape on threads when necessary to avoid such excessive fitting penetration.
- Check pump rotation and inlet/outlet pump port orientation before connecting power to pump. If not, injury may occur.
- When pulling cords from outlets do not pull cord, grasp plug to prevent plug damage or electrical shock.
- VmP drive motors become HOT and can cause a burn. **DO NOT TOUCH!**

1.2. Theory of Operation

The valveless pumping function is accomplished by the synchronous rotation and reciprocation of the ceramic piston in a precisely mated ceramic cylinder liner. One complete piston revolution is required for each suction/discharge cycle as shown. The piston always bottoms for maximum fluid and bubble clearing. Moving the pump head position changes the piston stroke length and in turn the flow rate. Flow rate indication through the controller provides for accurate and simple linear calibration.



The piston rotates and reciprocates. As the piston is pulled back and the piston flat opens to the inlet port, suction is created and fluid fills the pump chamber. As the piston reaches the highest point in the reciprocation cycle, the pump chamber is now at its maximum volume capacity. Continuing the rotation, the inlet port is then sealed

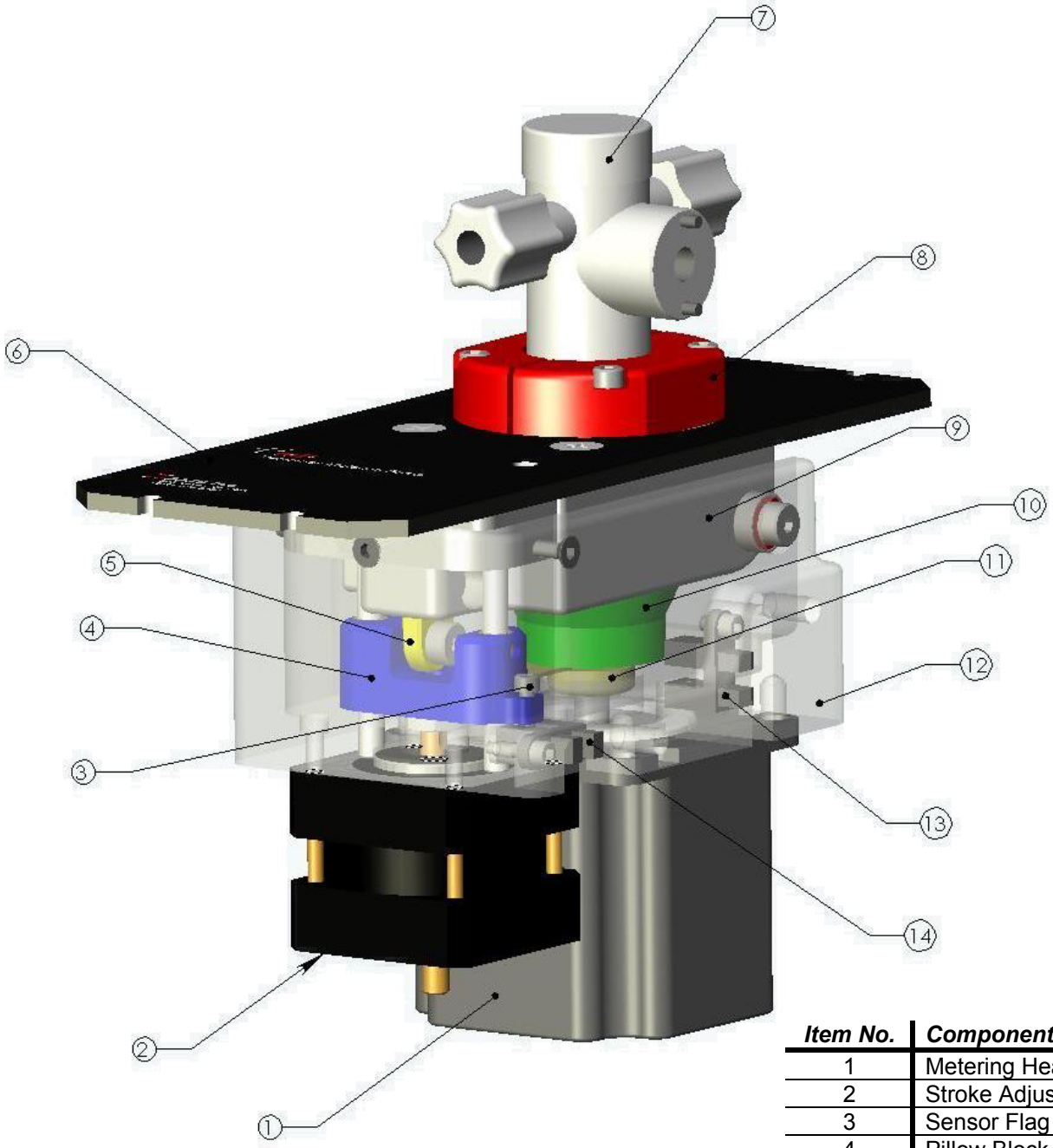
and crossover occurs. As the inlet port is sealed and the pump chamber is full, the outlet port opens up. ***Only one port is open at any time and at no time are both ports interconnected.***

Continuing the rotation and reciprocation, the piston is forced down and the piston flat opens to the outlet port. Discharge is created and fluid is pumped out. The piston bottoms for maximum fluid and bubble clearing. Continuing the rotation, the outlet port is then sealed

and crossover occurs. As the outlet port is sealed and the pump chamber is empty, the inlet port opens to start another suction stroke. ***Only one port is open at any time and at no time are both ports interconnected.***

1.3. Metering Head Features and Components

- 99.8% pure AL_2O_3.
- One moving part in contact with fluid.
- Displacement adjustable.
- Low dead volume.
- Low liquid shear.
- Abrasion resistant.
- Self-priming.
- Reversible.
- Valveless operation.
- Self-sealing design.
- Durability.
- Chemically inert.
- Autoclavable.



Item No.	*Component Description:*
1	Metering Head Drive Motor
2	Stroke Adjustment Motor
3	Sensor Flag Screw
4	Pillow Block
5	Drive Link
6	Mount Plate
7	Metering Head
8	Metering Head Clamp
9	Metering Head Angle Arm
10	Spindle Assembly
11	Sensor Flag, Metering Head
12	Motor Module Body
13	Metering Head Location Sensor
14	Stroke Home Sensor
15	

1.4. Materials of Construction

VmP wetted components are fabricated of carefully selected materials. Each one has discrete characteristics of physical strength, abrasion resistance, and dimensional stability under varying conditions of pressure, temperature, and resistance to attack by certain chemicals. Since no one material possesses all of the characteristics required to handle all chemicals under all possible conditions, Zaxis offers a selection of materials of construction for each pump component that fluids contact during the pumping process. These components and materials are identified on page ? of the catalog by code designation, common usage names and trade names.

General characteristics are as follows:

C-Ceramic

Ceramic is used in most of the pumps for **piston and/or cylinder liners**. Ceramic pistons may be used with ceramic and carbon cylinder liners. Ceramic cylinder liners can only be used with ceramic pistons. Sapphire hard, fused crystalline alumina (99.5% Aluminum Oxide) has excellent chemical resistance, thermal stability and is mechanically resistant to common abrasives.

Caution: This material is subject to binding or freezing when stored after improper cleaning, brittle and subject to fracture under sudden impact loading, and is not suitable for very "dry" fluids such as hexane.

K-Fluorocarbon

Fluorocarbon PVDF is used for some **cylinder cases and tubing fittings.** This material is autoclavable to 240°F maximum. It has good chemical tolerance to most fluids.

Caution: Sensitive to degrading effects of some organic solvents, esters, and ketones.

S-Stainless Steel 316

Stainless Steel 316 is used for some **pistons, cylinder cases and/or tube fittings.** Not to be used as piston with ceramic cylinder liner. It has excellent chemical, and physical strength characteristics.

Caution: This material is subject to attack by some halides, strong acids, and bases. Also, is subject to surface abrasion and wear in piston application.

Y-Carbon

Carbon is used for some **cylinder liners**. It is suitable for use with stainless steel and ceramic pistons. It has a hard crystalline stage, ingot sintered, and pure carbon chemically resistant to most commonly used fluids.

Caution: This material is sensitive to strong oxidants and all abrasive materials.

T-Tefzel, E.I. Dupont Co.

Fluoropolymer E-TFE is used for **cylinder cases** in some metering head. It has excellent chemical resistance to most acids, bases and solvents. This material is autoclavable to 240°F maximum.

Rulon®AR, Furon Company

This material is a fluorocarbon, filled with PTFE and is used for **lip seals** in some pump heads. It has good chemical resistance, sensitive to some organic solvents and strong acids and bases. It is physically soft, resilient and non-abrasive.

Teflon®, E.I. Dupont Co.

Fluorocarbon PTFE is used for **seals and fittings** in some metering head and has excellent chemical resistance characteristics. It is soft, pliable, easily cut, nonstick surface chemically stable over a wide thermal range. It is dimensionally sensitive to temperature change and is not suitable for structural components.

2. System Components

2.1. Electronic Controller

Advanced solid-state electronics with microprocessor controls constitute the basic components in the VmP precision metering system. Years of customer input have led to the recognition that a metering system should provide the user flexibility of control. Forward and reverse fluid movement is readily available as well as linear adjustable rate control, volume select, prime and meter modes. Multiple channels, PLC interfacing, optional RS 232 communication, alarm systems and cycle outputs are a few of the optional control features available.

2.2. Motor Module

The second component forming VmP's metering system is the motor and base assembly. A 5ft shielded motor cable is available for connection to the controller, allowing even greater mobility and flexibility. **Note:** Cable length can be adjusted to your application. The base assembly is manufactured from 6061 T6 anodized aluminum and the assemblies are designed for both tabletop use or panel mounting with OEM equipment.

2.2.1. Metering Head Drive Motor

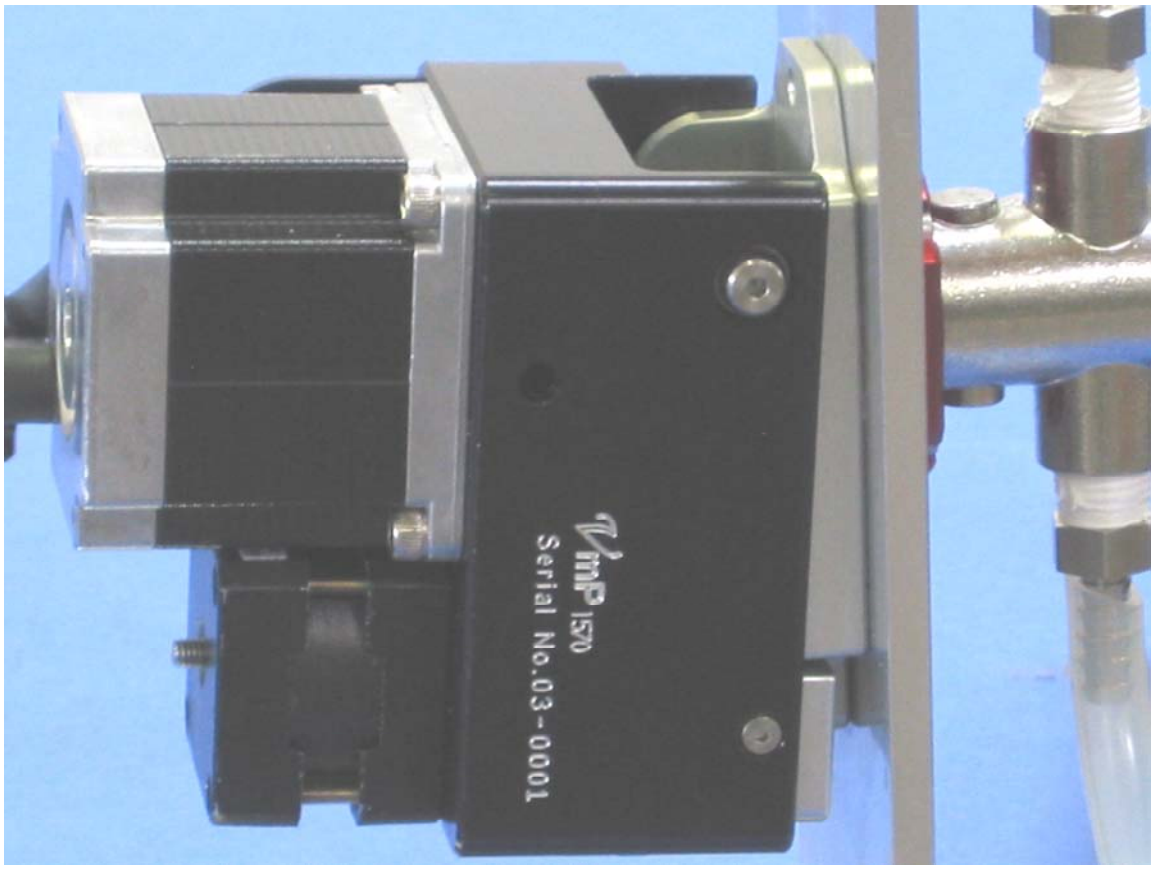
The metering head drive is a standard Nema 23 frame, 1.8°/step, hybrid stepper motor. For wiring diagram and detailed motor specifications, refer to section 8.

2.2.2. Ultra-fine Precision Stroke Adjustment Motor (UPSAM)

The stroke length linear actuator is a standard Nema 17 frame, 1.8° / step, hybrid stepper motor with a non-captive 10-32 lead screw through the center of the armature. This simple design results in considerable space savings. The user can make minute adjustments, via the control keypad, to the angle of the metering head (stroke length). With the stroke length controlled so precisely, the displacement is infinitely adjustable between as 0 to 1280 µl (1.28 ml). The adjustment revolution is 0.014uL per step. This amount is difficult measure without averaging many dispensed shots.

2.2.3. Stroke Adjustment Mechanism (SAM)

The patent pending linear adjustment control mechanism smoothly transfers control from the UPSAM to the metering head angle plate. The SAM accomplishes this transfer of control with zero backlash, to accommodate accuracy and repeatability.



2.3. "Q" Style Metering Head (QSMH)

The third element in the VmP system is the metering head. This head is in-line with the fluid path and is designed to be detached for ease of cleaning and autoclaving. The metering head is a piston/cylinder arrangement utilizing positive displacement. The heart of the metering head is the piston, comprised of a high density AL_2O_3 ceramic and /or strengthened and polished zirconia ceramic (YTZP). Each piston and cylinder set must pass a stringent quality control procedure which includes measuring the component to 10 millionths of an inch. 316 stainless steel, Delrin, Tefzel and Kynar are just a few of the many materials available for the metering head. Some of the benefits are:

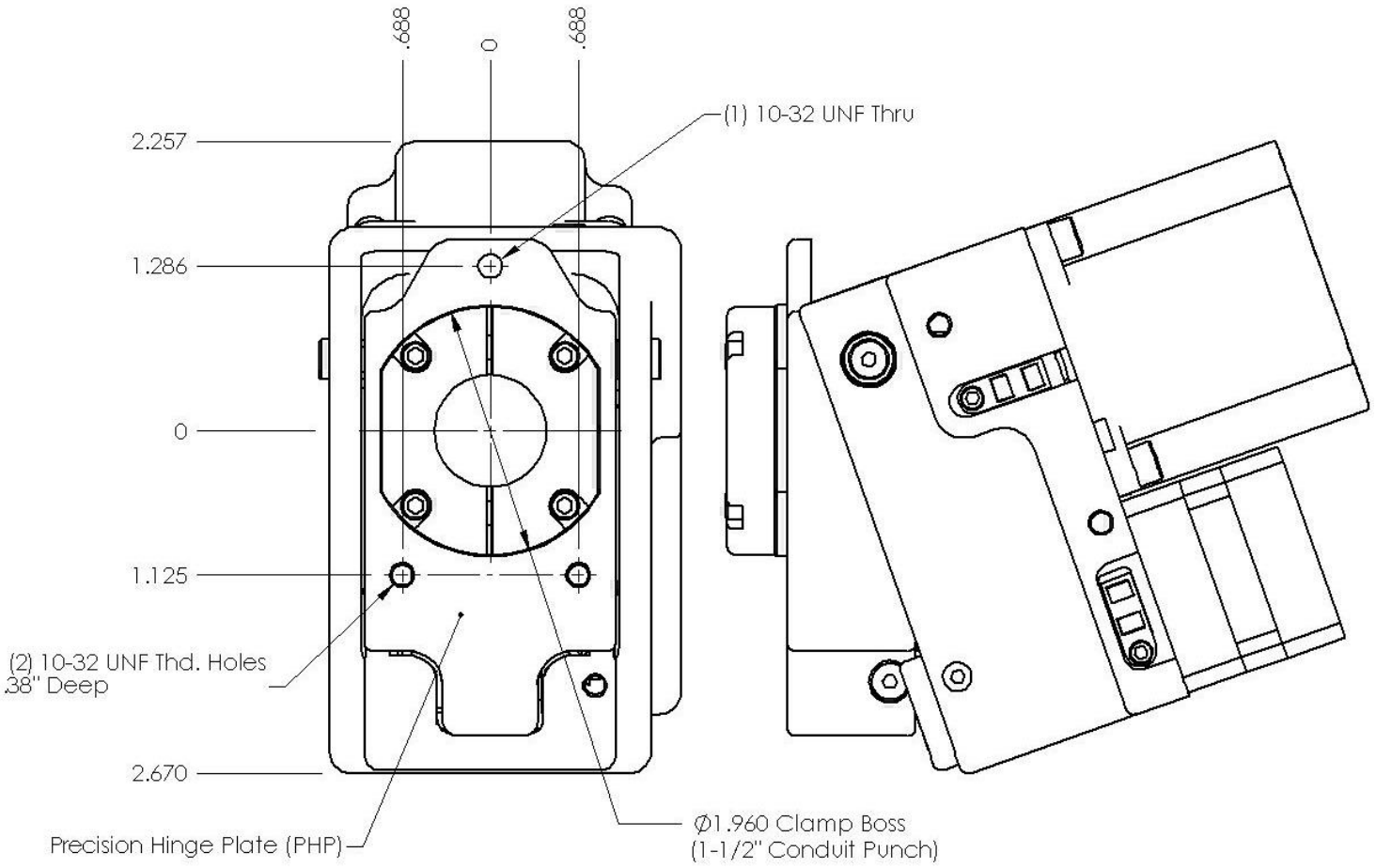
- **Low Friction,** The ceramic piston operates within the ceramic liner with no lubrication other than the fluid being metered.
- H**ardness,** The ceramic materials are extremely hard and resist abrasion, resulting in a system that exhibits little to no wear even after hundreds of millions of cycles.
- **Chemical Compatibility,** The QSMH has a ceramic and fluorocarbon fluid path giving the pump are compatible with most acids and bases. The natural crystalline structure of our ceramics displays zero porosity, which ensures zero retention and carryover of one biological fluid to the next.
- **Stability,** The ceramic materials are extremely stable, allowing for precision machining. Diamond tooling is used to produce parts with close running fits (100 millionths of an inch standard).
- **Self-Sealing Design,** The combination of the ceramic material's physical characteristics of low friction, hardness, and stability allows for the head to be sealed by the close clearance of the piston/cylinder fit. This means that no compliant seals are used, thus eliminating a part that requires frequent replacement in traditional pump designs.

2.3.1. Metering Head Characteristics

The QSMH has a ceramic and fluorocarbon fluid path giving the pump excellent chemical resistance. The QSMH has two flow rate ranges; the STQ high flow range (0-1.28ml) or the STH low flow range (0-100µl). The QSMH can yield an accuracy of 1% or better and has a Cv of 0.5% or better.

2.4. Metering Head/Motor Module Mounting

For optimum pump performance it is recommended that the VmP metering pump be mounted in a vertical position with the Discharge Port up and the Suction Port down. This orientation will allow air bubbles that enter the pumping chamber to directly exit through buoyancy assistance. There are (3) 10-32 threaded mounting holes (see illustration below) that surround the 1.960" dia. (49.8mm) pump clamp boss on the Precision Hinge Plate (PHP). This allows bulkhead mounting thru front panels used in automation. The SAM stays mounted when doing removal of the pump head only.



3. Getting Started

Upon unpacking, inspect all the components to make sure they are all present and that no damage has occurred. Remember to register your pump head with Zaxis Inc. They have three convenient ways to do so. Mail your registration form to Zaxis Inc., Call Zaxis Inc. or register on-line??.

3.1. General Set-up

Connect the controller to an appropriate power source (90/240VAC, 60/50Hz). Connect the patch cable to the controller's 16pin circle DIN connector and the other end to the pump connector (the cable can only be connected one way).

With the pump mounted, the tubing can be connected. The most resilient tubing with the largest inside diameter possible must be used for the **Inlet (Suction)** side of the pump. This will minimize the chance of cavitation. For the best metering performance use rigid PE tubing, with an equal or smaller inside diameter than the inlet tubing, for the **Outlet (Discharge)** side of the pump. This will reduce the peristaltic action.

Strokes Per Minute (spm) recommendations: For fluids of 500cps viscosity or less a stroke rate of 120-350spm maximum is ideal. For fluids with greater than 500cps a slower rate is recommended.

Controller Keypad Navigation

Moving around the Keypad is quite simple. The Keypad has (16) tactile feel keypads, giving the user positive control feedback while operating the metering pump. Metering information is read on a bright 2 x 20 character LED display. Use the function keys (F1-F4) to select the parameter to be programmed. Once selected, increment and decrement the values using the +/− keys.

3.1.1. Home Screen

Start: HOME. This is a good place start. As a standard practice, push this button if any question. At that point the function buttons: F1, F2 and F3 are accessible.

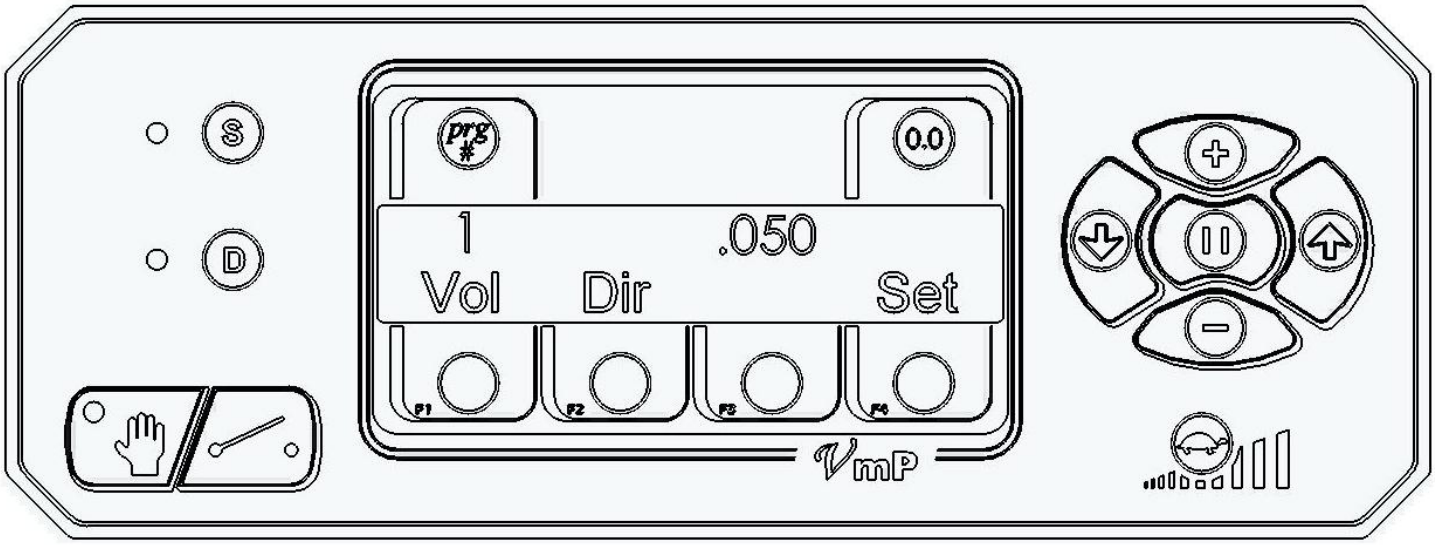
Vol: is indicated above F1 function buttons.

Push F1. Now you are ready to set shot size. For example, 3.2.2 will illustrations how it will appear.

The CURSOR will be blinking on the value above F2. Using the +/- Keys, increase or decrease the volume. The units of measurement are milliliter.

Push II to enter. Yes or NO will appear. If you push yes, then the new volume will be entered and the pump adjustment will drive to home and then to the appropriate stroke length. If you push NO then the old Volume will remain. And the adjustment will not occur.

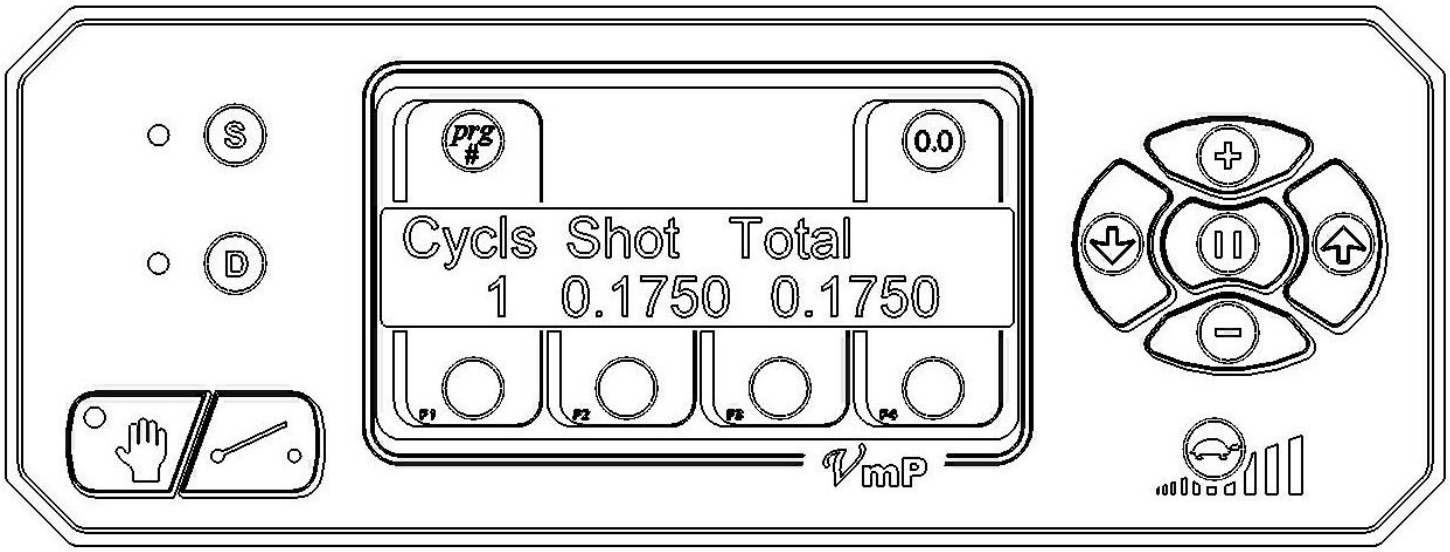
CYCLS: In the 3.2.2 illustration it displays a **1** above **F1**. That will allow the pump to rotate only one revolution, i.e. volume of 0.1750ml.



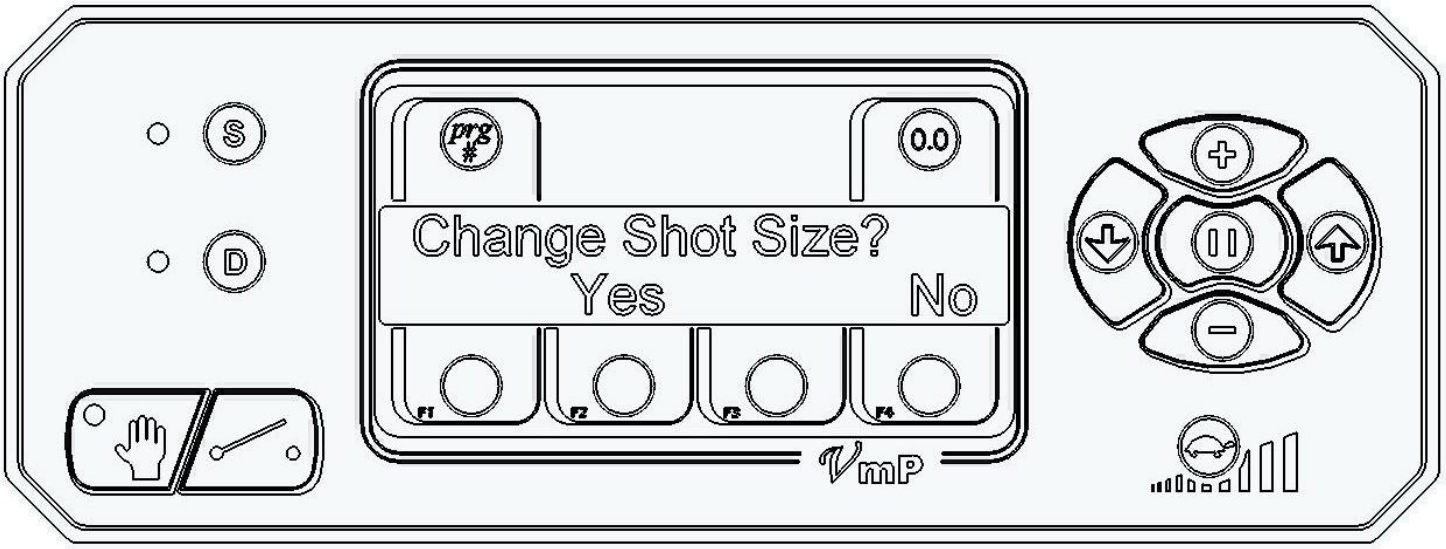
If you were to push F1 the CURSOR would start blink at CYCLS. Using the +/- keys, you can increase or decrease the number of cycls. Each cycle is equal to one Revolution of the pump motor. Notice the controller will total the dispense volume, e.g. program a 2 in the case of the illustration 3.2.2 would total 0.350ml.

Press to Start the Dispense……..

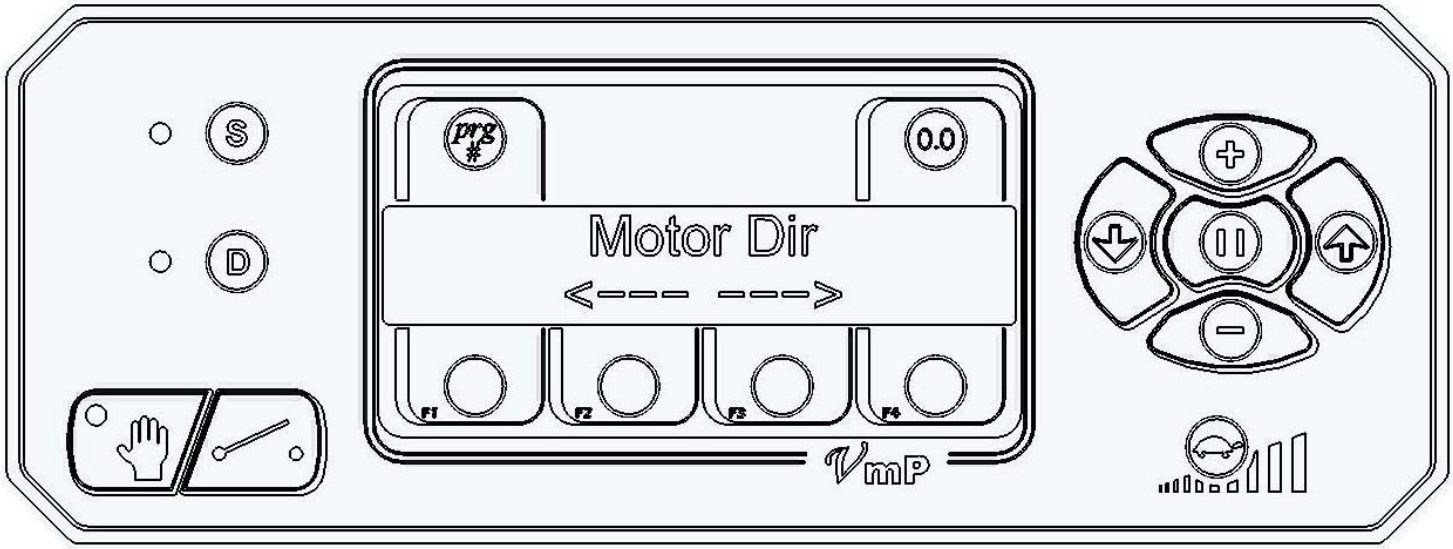
3.1.2. Metering Setup Display



3.1.3. Program Change Display



3.1.4. Motor Direction



3.2. Typical Applications

- **Medical:** Used for precise dispensing, aspirating, rinsing, & mixing systems and for syringe pump replacement in diagnostic, clinical chemistry, dialysis and medical equipment manufacturing. Also, used for dispensing adhesives and lubricants used in assembly of disposable medical components.
- **Industrial:** Used for accurate metering and mixing of paint & pigment additives, catalyst for foundry resins, plating bath regeneration, petroleum additives, photo chemicals, inks, monomers and adhesives.
- **Instrumentation:** Used for all kinds of precision instruments and monitors including, titrators, TOC, SO_2 monitors, chromatographic systems, and humidity control.
- **Precision Cleaning:** Used for metering of concentrated cleaning agents used in automated washers for laboratory glassware & mechanical components, as well as the metering of ultra concentrated liquid car wash detergents.
- **Automotive:** Used extensively in hydrogen fuel cell research & development for both the humidification and fuel injection systems. For metering insulating and encapsulating coating materials in the manufacture of stators, armatures, and distributors. Also, used in instrumentation to verify gasoline octane rating.
- **Battery Manufacturing:** Used for precision metering of electrolytes & slurries into batteries, as well as for lubrication of fine blanking machines used to form and stamp battery components.
- **Cosmetic & Hygiene:** Used for precision metering of pigments used in cosmetic color mixing systems. Also used for moisture control and fragrance addition in the manufacture of diapers and sanitary napkins.
- **Electronics Manufacturing:** Used for metering of ceramic slurries in the manufacture of capacitors and diodes. Used for the metering of insulating and encapsulating materials used in electric motor manufacture, addition of flux for wave soldering equipment, metering of mercury for switch manufacturing, and metering of semiconductor wash & etch solutions.
- **Pilot Plant:** Used for research, development, and testing of a wide range of process applications including chemical synthesis, water & waste treatment, power plants, pharmaceutical manufacturing, petroleum refining, photo finishing, and more.
- **Environmental & Pollution Control:** Used for sampling of stack gases, ground water, and wastewater, as well as injection of monomers, polymers, and treatment chemicals for water & waste, TCLP and more.
- **Food & Dairy:** Used for candy coating and polishing, vitamin fortification for milk, addition of flavors, colors, and preservatives, hops for brewing and sanitizing agents for aseptic packaging. Also, used for sample and reagent fluid control in milk analyzers and other food quality control instrumentation.
- **Spraying Systems:** Used for the injection of insecticides, herbicides, and agricultural nutrients. Also, used in ULV spray equipment for mosquito control.
- **Metering Systems:** Used for metering of solvents, UV adhesives, lubricants, reagents, and mercury in the manufacture of medical disposable components, electronics, pharmaceuticals, computers, and calibration equipment.

3.3. Application Tips

- **Pressure:** In most VmP pump models, motor starting torque is the limiting factor in the stated pressure rating. Fluids such as oils, creams and gels that are good lubricants are more easily pumped than aqueous or "dry" fluids and therefore require less motor torque and may be pumped against pressures considerably greater than those given in the rating charts.

  All pump head components are designed to withstand backpressures up to 100 psig at room temperatures, though pump heads with fluorocarbon cylinder cases may exhibit some loss of pumping capacity at pressures over 60 psig.

  Note: Check your fluid circuit before applying power to the pump!

- **Accuracy:** VmP pump accuracy is based on a simplified positive displacement mechanism. The valveless design provides an accuracy of better than 1% when handling medium viscosity fluids (50 to 500 centipoise). Aqueous solutions and light solvents work well but my exhibit some sensitivity (fluid slip) to variations in discharge head pressure. Gums, gels and non-abrasive semi-solids are handled with a high degree of accuracy… a direct result of the valveless design.

  Viscous, tacky solutions, semi-solids and heavy slurries which tend to resist (cavitate) suction flow into a pump head can be handled with ease by selecting a slower reciprocation rate (pump speed).

  The principal flow rate deviations of a VmP pump are fluid slip and stroke repetition rate. These two factors in turn are related to load factors such as viscosity, differential pressure, and drive motor voltage. When these two factors are controlled, the VmP will handle most fluids with reproducibility of better than 0.5%.

- **Importance of clean fluids:** Caution must be exercised in the use of abrasive fluids in any metering pump. Abrasives in the pumped fluid may damage cylinder and piston surfaces and should, therefore, be avoided. Carbon cylinder liners and stainless steel pistons are particularly susceptible to abrasion by particulate matter in the pumped stream. Ceramic piston/cylinder components are more tolerant of suspended solids except for those solids that tend to flock and impede the movement of the piston in the cylinder.
- **Compatible fluids:** Pump only fluids compatible with the materials of construction of the pump head you have selected (see section 1.4).
- **For best pumping results:** Select a VmP pump having maximum flow rating as near to the desired flow rate as possible.
- **Wet Operation:** The pumped fluid provides surface cooling and lubrication to the piston and cylinder of the VmP pump. Therefore, avoid dry operation.
- **Piston Seals:** The ZR408 seals that keep the pump piston dry are precisely cut and hot formed from sheets of a chemically inert fluorocarbon, specifically formulated for resistance to wear, abrasion, heat and chemical attack.

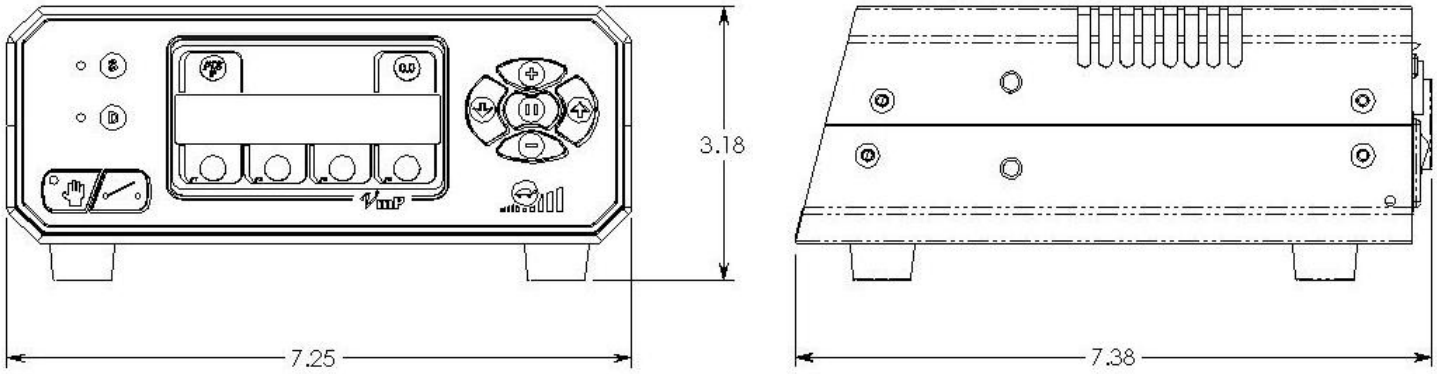
  Each ZR408 seal possesses an exceptional mechanical memory, allowing them to maintain a relatively constant wiping pressure on the piston, compensating for seal wear as it occurs. Properly maintained in clean condition, the original seals can last the life of the pump. If they are removed for any reason, they should be carefully cleansed of all foreign particles prior to re-assembly. Seal seats must also be free of particles (see section

3.4. Adjusting Metered Volume
3.5. Metering Hints

4. Control Keypad Description (advanced operation)
4.1. Keypad Keying Guidelines
4.2. Detailed Button Function
4.3. Typical Keypad Navigation

5. Electrical / Physical Specifications

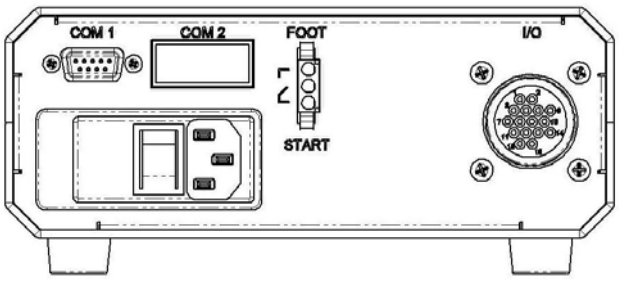
5.1. Electronic Controller



Physical Specifications…

Dimensions: 7.25" x 7.38" x 3.18" **Weight:** 2.5 lbs.

Material of Construction: Painted aluminum sheet metal with white non-marring rubber feet.



Electrical Specifications:

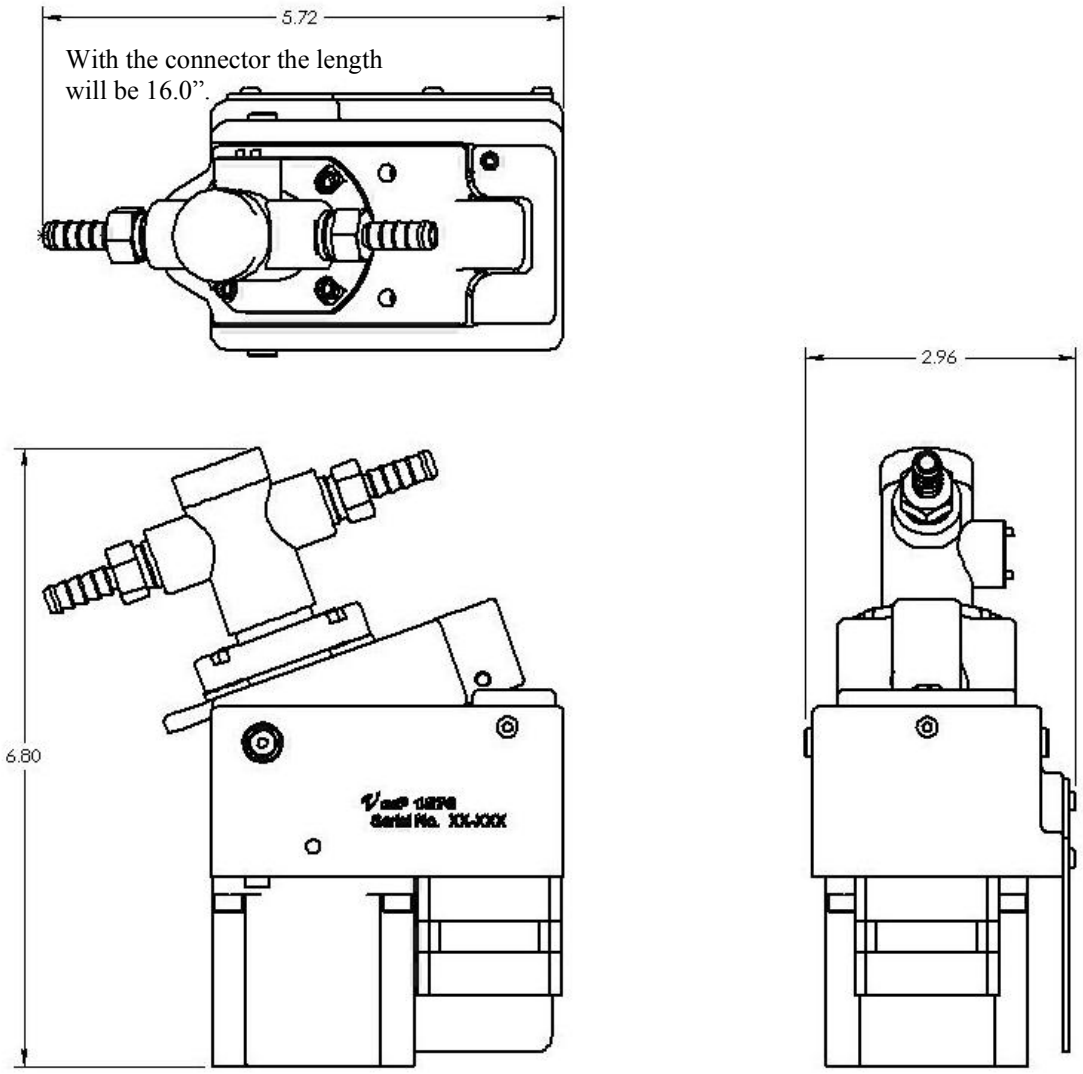
Power: 90 / 260VAC, 50 / 60Hz, Std. IEC 320 connection.

Operating Current: 75mA @ idol, 392mA peak, 350mA avg.

Fuse: 5mm x 20mm ½ Amp, Time delay (located behind the outer panel in the power entry module).

Foot Switch: Dry Contact. **Com 1:** Serial port. **Com 2:** Customizable. **I/O:** Interface with pump.

5.2. Motor Module



Physical Specifications:

Dimensions: 6.80" x 5.72"(15" with conn.) x 2.96" **Weight:** 3.5 lbs.

Mounting: The Motor Module can be mounted in a bulkhead or panel. It also can be mounted into a stand and set on the bench or tabletop (refer to section 2.4, "Metering Head/Motor Module Mounting").

Metering Head Construction: Piston and cylinder lining are Sapphire hard (fused crystalline alumina, 99% Aluminum Oxide). Motor Module body is constructed from 6061 Aluminum with surface black anodizing.

Capacity:

Maximum Dispense Rate: (Total displacement, TD) Heads are interchangeable.

0.32ml TD ~1ml/sec. 0.65ml TD ~2ml/sec.

1.25ml TD ~4ml/sec.

Minimum Dispense: ~5% of full scale. **Minimum Dispense Rate**: < 0.01uL/sec.

Stroke adjustment: 0.0144uL per step, Stepper motor linear actuator.

Drive Motor: Stepper motor, 1.8 degree., 200 steps per revolution. One complete revolution equals one stroke.

Ambient: Temperature: 4-35 °C without condensation.

Life expectancy: 84 million cycles.

Accuracy: .5% of full scale.

Repeatability: .1% of full scale.

5.3. Metering Heads

6. Troubleshooting

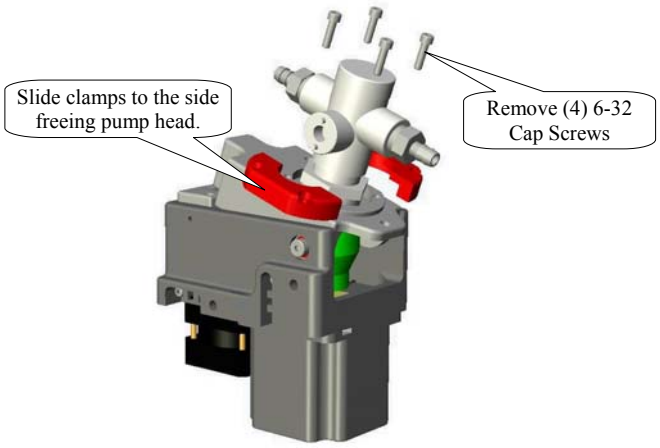
Item	*Problem*	*Possible Solutions*
1	Blow By	•
2	Inconsistent Shot Size	• Blow by. • There is air in the meter barrel. - Air entering the meter fluid during filling of the barrel. - Air entering the meter fluid as a result of excessive pullback. • Meter speed to great for fluid viscosity and needle combination.
3		

7. Service

7.1. Metering Head Removal and Disassembly

a) To remove "Q" Style Metering Head (QSMH):

1. Turn power off.
2. Via the controller, adjust the QSMH to maximum stroke length.
3. Rotate Spindle Assembly 200141-1 so the Piston Drive Pin is pointing towards the connection linkage.
4. Remove the (4) 6-32 cap screws from the clamp collar securing the QSMH (see illustration).
5. Carefully lift the QSMH away from the Precision



Hinge plate. Rotate the QSMH as it is lifted, so that the suction port and the discharge port approach horizontal level. Once this is accomplished, the Piston Drive Pin can be slide out of the spherical bearing in the Spindle Assembly. This should free the QSMH from the Motor Module.

Caution! Pull piston from Cylinder Case just enough to remove the QSMH from the Motor Module. Damage to the Piston Seal will result if the Piston extends from the Cylinder Case an excessive amount.

b) To replace the QSMH:

1. With Piston ZR423 extended approximately 1-1/4" from Cylinder Nut ZR406-S and the piston Drive Pin pointing toward the connection linkage, insert Drive Pin into the Spherical Bearing in the Spindle Assembly.
2. Slide the QSMH into position on the Precision Hinge Plate, making sure the body of the Cylinder Nut seats into the locator bore.
3. Place the Pump Clamps over the hex on the Cylinder Nut and replace the (4) 6-32 cap screws, tighten until pump is secure. **DO NOT over-tighten, damage may result.**

7.2. Metering Head Cleaning

7.2.1. Standard Cleaning Requirements

Routine flushing with solvent before shut-down will suffice for most applications – set pump for maximum stroke and operate until solvent appears clear at discharge port. If periodic teardown for detail cleaning is required, remove parts with care to avoid damage to piston, cylinder and gland. Wipe all parts with lintless oil saturated cloth. Operate by hand after reassembly to assure free movement of parts prior to application of power. **Caution!** Ceramic piston/cylinders sets are particularly sensitive to neglect and may "freeze" if allowed to dry out without adequate cleansing.

One way to avoid the Piston from freezing in the Cylinder Liner, is to remove the piston from the cylinder after solvent cleaning and store the component parts in disassembled condition until the pump is again required Another method is to fill a loop of flexible tubing with fluid that will thin or neutralize the last fluid pumped. Then connect one end of the tube to the pump suction port, the other to the discharge port. With this loop positioned above the pump head, the ceramic surfaces and seal areas will stay moist and mobile for extended idle periods. If, However, a piston (ceramic or stainless steel) does freeze in the cylinder, **DO NOT TRY TO FORCE IT FREE!,** Be gentle. Try to remove the pump head (refer to 7) from the base assembly so that the whole assembly can be soaked in a suitable solvent. If the head is not conveniently removable, the tube loop discussed in the prior paragraph may permit solvent to dissolve the "frozen" residue in a reasonable time. If all else fails, package the pump and ship it back to the factory with a short explanation telling us what the last material that was in the pump. We will free the piston and return it to you for a nominal fee plus shipping and handling. Having a spare pump head on hand in case of emergencies is always a good idea.

7.2.2. Sanitary Cleaning Requirements (Applies only to the sanitary metering head)

VmP sanitary metering heads, designated SAN are designed to conform to cleansing standards of the U.S. Food and Drug Administration.

To clean individual component parts:

a) Unscrew Cylinder Nut ZR406-S and 2 Port Nuts 110348-P.
b) Remove piston and seal components released by step a) above;
c) Use fingers to wiggle liner ZR407-C slipping it from Cylinder Case ZR405-SAN;
d) Cleanse and sterilize component parts as per government regulations for parts manufactured of Alumina Ceramic, Type 316 Stainless Steel and Teflon. After, cleaning, reassemble the components as follows:
e) Assemble piston/seal components as per instruction paragraph 7.3 steps a, b and c;
f) Orient Cylinder Liner ZR407-C in Cylinder Case ZR405-SAN in such a manner that the side port flats on Cylinder Liner ZR407-C should be visible through the side port openings on Cylinder Case ZR405-SAN.
g) Place each port seal component ZR412-T into each side port of Cylinder Case ZR405-SAN using finger pressure across the two opposing ports to assure complete seating of the seal surfaces on the Cylinder Liner flats.
h) Apply Port Nut 110348-P to each port, finger tight.
i) Carefully insert piston into cylinder liner until threads of Cylinder Nut ZR406-S meet threads of Cylinder Case ZR405-SAN. Tighten Nut ZR406-S finger tight.
j) Place head seal components 2 ZR408- and ZR409- into the threaded end of Cylinder Case ZR405-SAN; apply Cylinder Nut ZR406-S.
k) Wrench tighten each Port Fitting ZR412-0 1/6 of a turn.
l) Wrench tighten Cylinder Nut ZR406-S 1/2 turn.

7.2.3. Piston Seal Replacement

When ZR408 seals are replaced, the following procedure must be followed to insure that the seals are not damaged:

a) Place gland nut ZR406 and gland washer ZR409 on piston assembly ZR423.
b) First, "form" lip of Lip Seal around piston by gently placing a Lip Seal ZR408 on piston, **lip side last**. Carefully rotate the seal on the piston to avoid damage to the lip while passing over the flat to the piston neck. **Then remove seal and reverse lip direction.**
c) Gently place one "formed" Lip Seal ZR408 on the piston, **lip side first**. Carefully rotating the seal on the piston until it is past the flat and on the piston neck.
d) Gently place one "formed" Lip Seal ZR408 on the piston, **lip side last**. Carefully rotate the seal on the piston to avoid damaging the lip while passing it over the flat to the piston neck.
e) Insert piston into cylinder approximately one inch.
f) Apply Gland Nut ZR406 to cylinder threads and tighten.

7.2.4. Piston Seal Setting

After installing new lip seals (part ZR408) in metering head it is recommended that the seals be set (formed in place) by fluid pressures generated by metering action. To accomplish this:

a) Operate the metering head spindle clockwise for 10 to 20 strokes at maximum setting, handling water with the suction line blocked or pinched off. This will create a vacuum in the metering head, permitting atmospheric pressure to shape the outer seal member tightly around the piston.

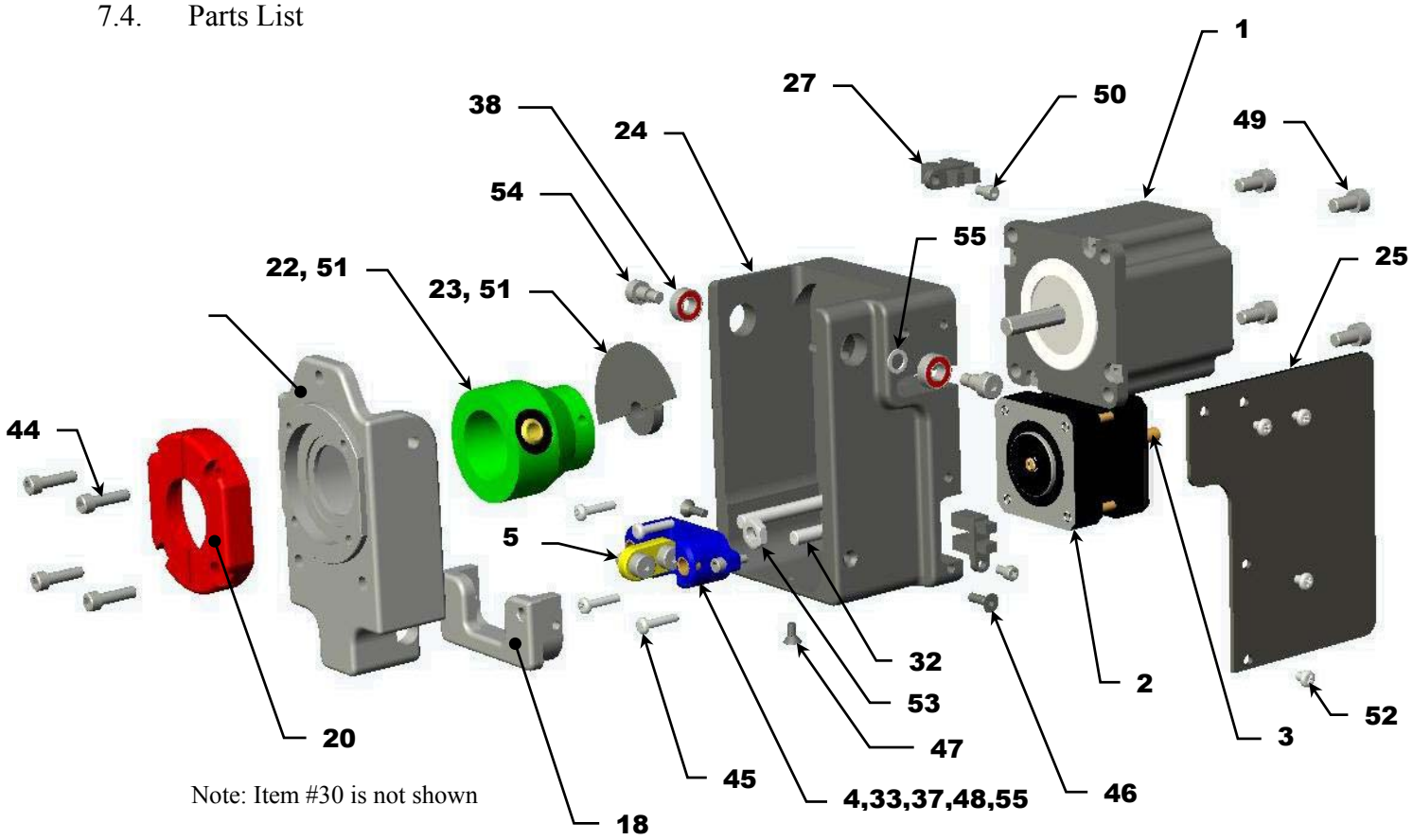
b) Reverse the metering direction and intermittently block this same line. This will generate pressure in the seal area of the metering head, causing the inner seals to form intimately around the piston.

7.3. Metering Head Reassembly

7.3.1. Lubrication

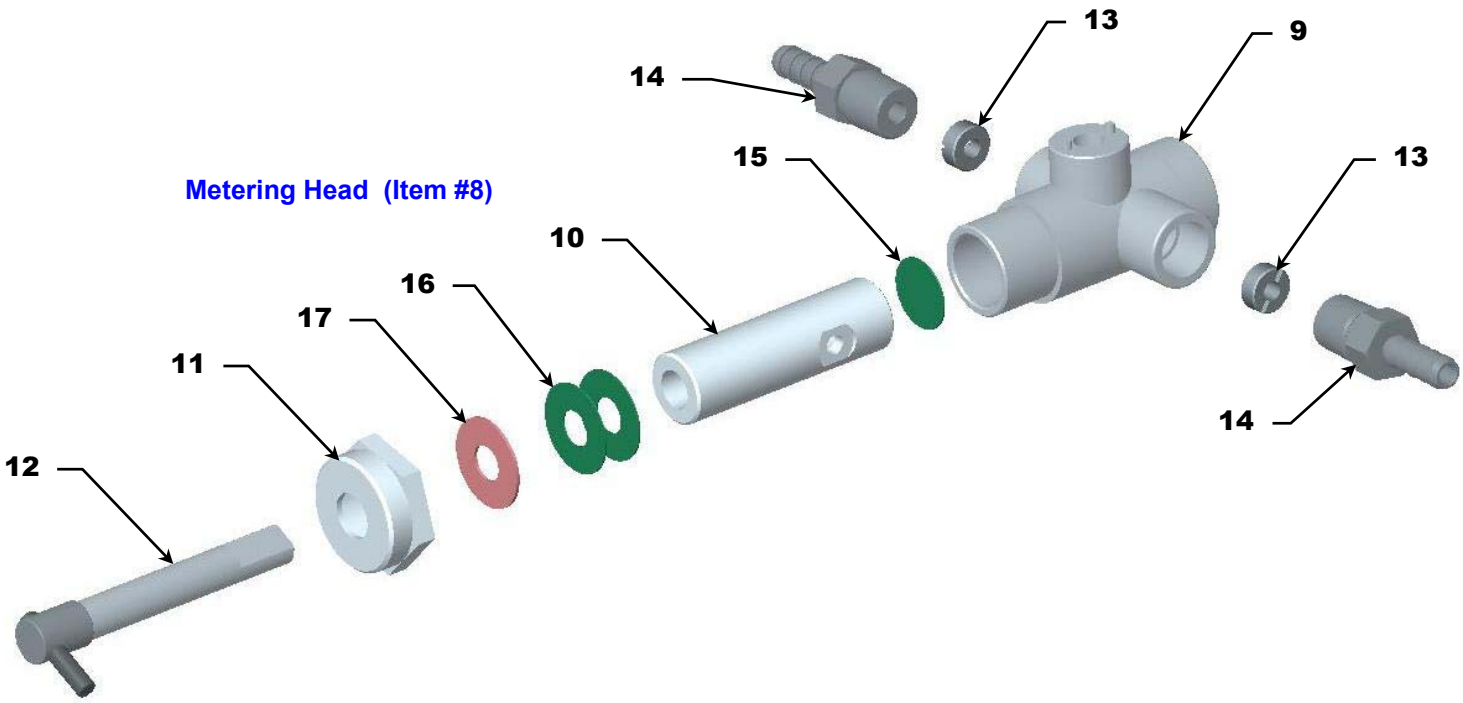
Pump drive elements are provided with oil fittings at all appropriate points. Use high-grade machine oil at regular intervals. A small amount of premium grease on the Piston Drive Pin just before it is inserted into the Radial Bearing in the Spindle Assembly greatly increases the life of the pin and the spherical bearing. This joint is lubricated at the factory prior to shipment.

7.4. Parts List



Note: Item #30 is not shown

Metering Head (Item #8)



See Excel spreadsheet Doc. No. ZD001-04-ORG for Bill of Materials.

7.5. Recommended Spare Parts List

The metering head is the only serviceable component in the VmP system. The components included are items 8-17 on the bill of materials (page 27). The cylinder liner and piston are matched sets and must remain together to function properly. If for some reason the cylinder liner or piston is damaged it is best to replace both components. All the seals are readily serviceable, although care must be taken during disassembly and reassembly. Call Zaxis for more information regarding spare parts.

8. Warranty

ONE YEAR LIMITED WARRANTY

Zaxis Inc. Limited Warranty

Zaxis products are manufactured to a high level of mechanical precision from materials that are resistant to attack by many corrosive chemicals. These products, however, may be self-destructive when used with non-compatible fluids or when located in physically hostile environments or when operated under non-specification voltage or pressure conditions.

Zaxis, therefore, warrants only as follows:
Each metering head has been test operated with water to rated pressure prior to shipment from the factory. The qualifying performance of each metering head is recorded by serial number in a permanent record of the company. If at any time with-in the first year after any Zaxis product has been shipped to a customer (user), it fails to perform according to Zaxis literature, the product, with written explanation of the problem, may be returned, freight prepaid, to Zaxis for examination, repair or replacement at Zaxis expense (labor and material). All such returns must have prior Zaxis customer service authorization before returning. If, upon examination, Zaxis determines that abusive practices, non-compatible fluids or destructive environment of operation or a combination of these factors is responsible for improper performance of the product, all labor and materials costs involved shall be at the expense of the customer.

Zaxis is not liable for special, indirect or consequential damages that may result from use, failure or malfunction of the product, and any recovery against Zaxis may not be greater than the purchase price paid for the product.

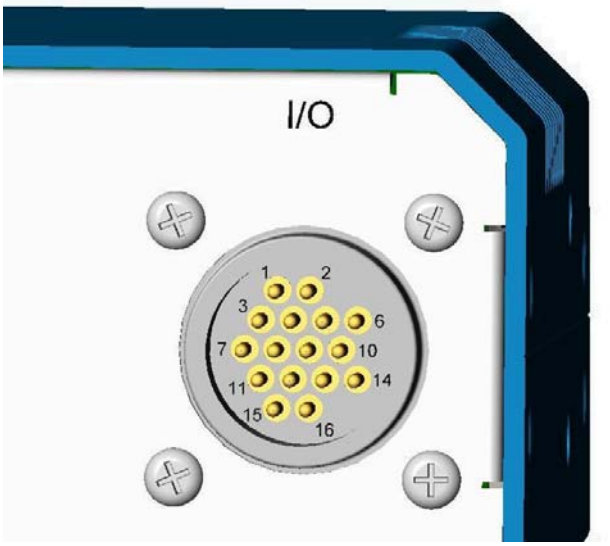
No person is authorized to change the terms of this warranty.

9. Electrical Schematics and Cable Pin-out

9.1. I/O Connector

Pin No.	I/O Description	Wire Color
1	Chassis Ground	N.C.
2		
3	Dispense A	Green
4	Dispense A’	Blue
5	Dispense B	Red
6	Dispense B’	Yellow
7	Adjust A	Red
8	Adjust A’	Blue
9	Adjust B	Green
10	Adjust B’	Black
11	Sensor +	Red
12	Sensor -	Black
13	Dispense Emitter	Green
14	Adjust Emitter	Green
15	Dispense Collector	White
16	Adjust Collector	White

Note: Black and White are common. Brown and Orange are common.



9.2. Motor Module

9.2.1. Metering Drive Motor

9.2.2. Stroke Length Motor

9.3. Sensors

10. Glossary of Terms

Administrator: Individual responsible for the implementation and management of the meter system.

Bore: Inside diameter of the barrel.

Centipoise (cP): A centimeter-gram-second unit of dynamic viscosity equal to one hundredth (10^{-2}) of a poise.

Poise (P): A centimeter-gram-second unit of dynamic viscosity equal to one dyne-second per square centimeter.

Positive Displacement: describes the volume of material displaced in a rigid system by a given movement of a piston in a bore.

Stroke: Distance the ceramic piston travels into the sleeve cylinder.

Strokes per Minute (spm): The number of times the ceramic piston cycles in a 60sec time period.

Target Fluid: The fluid that will be metered.

Viscosity: defines the ability of a fluid to flow, measured in centipoise (cP), i.e. water @ 208C = 1.0 cP, Honey @ 208C = 10,000 cP.

11. Technical Support

Refer to the "Troubleshooting Problems" section and verify correct setup before contacting technical support.

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79 W. 4500 S. Unit #21
Salt Lake City, UT. 84107

e-mail: tech@zaxisinc.com

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Phone: 1-801-264-1000
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